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Did the policy responses to COVID-19 protect Italian households' incomes?

Evidence from incomes nowcasting in microsimulation models

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Abstract This paper addresses the economic impact of the COVID-19 pandemic by providing timely and accurate information on Italian households' income distribution, inequality and poverty risk, assessing the effects of policy responses during 2020. The analysis nowcasts the income loss due to the economic shutdown since March 2020 and simulates most of the interventions adopted by the Government from March to December 2020 by integrating real-time firm level data in the micro-simulation model *TAXBEN-DF* (Italian Department of Finance) that relies on a unique and wide database of survey and administrative data at individual level. Results suggest that policy measures in response to the first pandemic year have been effective in keeping overall income inequality under control, not being able yet to avoid a concerning polarization of incomes and large heterogeneous effects in terms of both income losses and measures' compensation.

Key words: COVID-19, inequalities, administrative and survey data, microsimulation

JEL Classification: C63, C81, D31, D63, H31

1 Introduction

The COVID-19 pandemic risks exacerbating existing and new inequalities. The pandemic is having particularly adverse effects on younger workers, women and people that are more vulnerable and affected by longstanding socio-economic inequalities. Pandemics have been shown to increase new inequalities, in the form of job losses, income reductions, or exposure to health risks. As a result, income inequality, which was already high in all major advanced economies before the pandemic, is likely to rise further over the medium term, unless policies succeed in breaking this historical pattern.

Since the beginning of the COVID-19 crisis, a fast-growing literature underlined that the costs of the pandemic are being borne disproportionately by the most vulnerable social groups that were more likely to have lost their job or experienced a drop in their economic activity during the "Great lockdown".

Less educated and low-skilled workers, self-employed, younger or unstable employees (including the ones employed in the "black economy") have found to be concentrated in the sectors more affected by the shutdown, or also less likely to work from home (Blundell et al., (2020); Benzeval et al., (2020)). On these groups the consequences of the pandemic were more severe, while households of the top quintile, which were used to spend a third of their incomes on services restricted by the shutdown, experienced an unexpected form of savings (Crawford et al., (2020); Intesa San Paolo and Centro Einaudi, (2020)), reinvigorating such an inequality dynamic.

At the same time, new forms of disparity arose along various key dimensions: the *stay-at-home* policy led to a disproportionate burden on women increasing the gender inequality (Alon et al., (2020); Andrew et al., (2020a); Del Boca et al., (2020)). Schools' closures amplified education inequalities with strong advantage in favor of children from better-off families (Coe et al., (2020); Andrew at al., (2020b)). Health risks were more likely to be fatal for men and the elder, and those with lower income were more vulnerable to the infection (Blundell et al., (2020)).

In this context, the level of disposable income before and during COVID-19 is the crucial driver in exacerbating or mitigating the whole inequality dynamic. Policies aimed at protecting those most directly affected by the crisis, either through automatic stabilization (e.g., unemployment benefits)

or through discretionary interventions (e.g., income subsidies or non-refundable grants), have been adopted to alleviate the impact of COVID-19 on household income and inequalities.

Against this background, a key question in academic and policy current debates concerns the extent to which policy interventions in response to the COVID-19 outbreak have been effective in preserving households' incomes and fending off an increase in inequality and relative poverty (Gallo and Raitano, (2020); Brunori et al., (2020); Fiorio and Figari, (2020); Clark et al., (2021); Almeida et a. (2021); Brewer and Tasseva (2021)).

On the empirical ground, this paper contributes to the current debate thanks to a particularly rich and update database, addressing the economic impact of the COVID-19 pandemic on Italian households' income distribution, inequality and poverty risk, and assessing the mitigation effects of policy responses during 2020, overall and by different personal and familiar characteristics and type of economic measure. Therefore, the results support the design of future interventions aimed at absorbing similar types of generalized but asymmetric economic shocks affecting households.

On the methodological ground, it is worth noting that tracking household disposable-income inequality during COVID-19 poses several methodological challenges.

First, income-related inequality is one of the most important key variables in social science but it is difficult to measure accurately. In Italy, income data are available from many sources, including household surveys, tax records and administrative data from government program schemes providing transfer payments. Each source has important strengths and major limitations when used alone. Surveys provide rich social and demographic information that allows identifying families and households, supporting analysis by employment status, education, sector of activity, and other characteristics, but underreport certain types of incomes. Tax records are consistently and accurately collected, resulting in highly reliable data covering a large number of observations but are only available for those who file taxes, therefore missing the low-income population that falls below the filing threshold and non-compliant taxpayers. Units of analysis in the tax record may also not reflect the economic decision-making unit, such a household or family. Finally, administrative data from government programs provide details for safety schemes such as non-taxable cash transfers, automatic stabilizers and so on that are not always captured by other sources but, being only collected for administrative purposes, contain a limited range of variables.

Second, the asymmetric and heterogeneous shock induced by the pandemic is not captured by the available data sources. The lack of up-to-date information on the labor market and on the differential impacts across the population constrains the scale and direction of recent changes in the income distribution, which in turn does not allow timely, effective policy analysis and hinders the efforts to target income support measures. In fact, Personal Income Tax (PIT) returns and representative surveys data on population incomes and living conditions are usually available two years later from the year in which incomes have been earned.

To the best of our knowledge, this paper is a first example of how to overcome microsimulation shortcomings by using more timely and high frequency data at firm level to complement individual survey and administrative micro-data and nowcast incomes variation. In fact, the traditional nowcasting techniques in microsimulation consisting in incomes uprating (normally by using aggregated indexes on wage growth), updating of tax-benefits rules, and population re-weighting are not able to seize asymmetric shocks with heterogeneous effects (O'Donoghue and Loughrey (2014)). Instead, the proposed type of nowcasting estimation, integrated in a traditional microsimulation model, is particular effective to capture heterogeneity in incomes variation and assess in a reliable way the distributional implications of a generalized crisis with heterogeneous effects as the one stemming from COVID-19 pandemic.

The paper illustrates the micro-simulation model as suited for this analysis and data sources (Section 2); explains the counterfactual methodology used to estimate the impact of Government's interventions to mitigate the economic effects of the pandemic (Section 3); deepens the effects of interventions on income distribution, inequality and poverty risk overall and by different personal and familiar characteristics and by type of measures (Section 4); and outlines limitations and main policy implications of the analysis (Section 5).

2 Microsimulation model and data sources

The analysis relies on the static tax benefit micro-simulation model **TAXBEN-DF**, developed by the Italian Department of Finance (Ministry of economy and finance)[5]. The model combines different datasets integrated with an exact matching based on the identification tax number. In details, the datasets are:

i) Survey data from the Italian version of the survey EU-SILC for the year 2018 – which contains information on incomes (referred to 2017), personal characteristics, skills, education level, detailed information on socio-economic status and employment conditions for a large and representative sample of Italian households;

ii) Administrative micro-data drawn from Personal Income Tax returns of 2018, referred to fiscal year 2017;

iii) Real estate data from the national cadaster, again referred to fiscal year 2017[6].

iv) Financial assets data form the Archive of reports with financial operators.

v) Data on social contribution and pensions by the Italian National Social Security Institute (INPS);

Combining such information, the model is aimed at studying revenues and impact of fiscal policies and transfers to households (PIT, family allowance, Citizenship Income, housing taxation, social contributions) (Di Nicola et al. 2015).

As recalled insofar, PIT returns and representative surveys data on population incomes are usually available two years later from the year in which incomes have been earned, making micro-simulation models, in their static formulation, not able to capture the incomes dynamic occurred under particular shocks.

Furthermore, the traditional techniques used to nowcast in microsimulation – incomes uprating, updating of tax-benefits rules, and population re-weighting (O'Donoghue and Loughrey (2014)) – are not suitable to seize incomes variation in a context characterized by a high degree of uncertainty

[5] For more information about the model characteristics: https://www.finanze.gov.it/it/il-dipartimento/Modelli-economici-e-strumenti-di-analisi/TAXBEN-DF/.
[6] For this application, we did not use cadastral data, deriving property income from PIT returns, for individuals submitting PIT declaration.

and producing heterogeneous effects not only by type of main occupation (employment, self-employment and entrepreneurship) but also within each of these groups according to the economic sector and the professional category and duties. In fact, uprating incomes normally relies on a calibration using national account data or indexation of wage growth by source of income, but even when this is carried out by using micro level indices (Immervoll et al. (2005)), in general it does not provide differentiation by population sub-group. Similarly, to have reliable distributional effects in the pandemic case, it is not sufficient updating tax-benefits rules or re-weighting the population to adjust for changes in demographics, education or labor market characteristics that the COVID-19 actually produced in terms of a higher increase in deaths, a higher rate of non-renewal in fixed-term contracts and a lower rate of hiring.

Hence, linking the original TAXBEN-DF micro-data at individual level with new firm-level data that became recently available in real-time or with a short time lag at the Department of Finance, yields the most complete and accurate setting to estimates income losses, inequality and poverty, providing timely, updated and robust evidence on policies evaluation, even in the uncertain scenario of COVID-19 pandemic.

To this purpose, the model was properly extended to account for the households' income changes due to the pandemic and then used to evaluate the impact of the interventions in response to the pandemic and assess the distributional effects across different taxpayers' groups and territories (Figure 1).

In detail, the model was integrated with:

- data from firms' balance sheets, the electronic invoicing of 2020 and periodic VAT returns for 2020 (at firm level) to simulate the trends of turnover and costs for goods and services and, thus, derive the income variation experienced by self-employed workers and entrepreneurs;
- administrative firm-level data by the Italian National Social Security Institute (INPS) on the personnel cost actually paid in each firm, suited to define the recipients of the wage-supplementation scheme for working-time reduction *(Cassa Integrazione Guadagni, "*CIG") and the employees' income variation.

In order to match these new data sources with the micro-data at individual level of the TAXBEN-DF, we aggregated firm level data at economic sector (6-digit NACE level) and Italian region level, so that each combination of 6-digit economic sector and region is the key to input income variation for each individual.

3 Nowcasting methodology, the counterfactual research design and the discretionary Government's interventions

On a methodological level, our analysis shows how an approach that combines microsimulation and nowcasting is suited to provide real-time information, leveraging in particular on more frequent updates of firm-level data to input current individual changes in disposable income, so allowing to tailor policy responses to support household's income, poverty and inequality.

To assess the potential impact of such policy interventions, adopted in the wake of the COVID-19 crisis, we estimate a range of monthly indicators to produce short-term forecasts in the turnover, costs of goods and services, and personnel costs for each combination of economic sector at 6-digit NACE level and Italian region. These indicators have been developed by the Department of Finance and SOSE S.p.a to nowcast the individuals' income variation by differentiating between the income of self-employed and entrepreneurs (using the data from electronic invoicing and periodic VAT returns) and the income of employees (using the data on personnel cost by INPS).

We build a counterfactual analysis where we compare the hypothetical scenario in which COVID-19 have not occurred, the **COVID-free scenario,** with two alternative scenarios:

- the **COVID-no-interventions scenario** allows to gauge the effect of the only income losses, namely what would have been the economic effect of the pandemic on the households' incomes if no discretionary policy measures had been taken to cushion the impacts of the COVID-19;
- the **COVID-with-interventions scenario** simulates the impact of both the pandemic and the government policies on income distribution.

The COVID-free scenario acts as a baseline scenario to compare the households' socio-economic condition in a "normal" 2020, with respect to a world with and without Government's actions.

The effect of the extraordinary Government's interventions adopted during 2020 is estimated by comparing the with- and without-interventions scenarios. In order to isolate the effect of the only measures adopted to face the COVID-19 emergency, all these three scenarios include the fiscal policies that were already in force in 2020 or planned to become fully operational during the year, as in the case of the Citizenship Income and the measures to reduce the tax-wedge for employees with yearly incomes under 40.000 euros.

To estimate the 2020 working incomes deriving from the pandemic shock, for each month between March and December 2020, we applied the monthly indicators of individuals' income variation to the individuals' incomes from 2018 PIT returns (incomes of 2017), uprated at 2019.

In the COVID-no-interventions scenario, we assume that without the blocking of layoffs and the extension of the "CIG" between March and December 2020, employees would have lost their entire salary for a number of months equal to the number of estimated months in which they received the "CIG".

In the COVID-with-interventions scenario, to the income variations caused by the economic shutdown since March 2020, we add the simulation of most of the measures designed to support workers' incomes and to protect firms' jobs during the COVID-19 pandemic.

In detail, we simulate the following combination of policies (see Box 1 for a complete picture of data, assumptions, measures and nowcasting method):

- For employees: the wage-supplementation scheme for working-time reduction ("CIG") for a maximum of 10 months between March and December 2020 and the blocking of layoffs for the entire period;
- For self-employed workers and entrepreneurs: the 600 euros lump-sum benefit in March and April (Decree-Law "*Cura Italia*"); the 1.000 euros lump-sum benefit for self-employed professionals in May (Decree-Law "*Rilancio*"); the non-refundable grant aid corresponded for 3 months and the tax credit for rents for non-residential purposes corresponded in March, April, May, October,

November, December (Decree-Law "Rilancio", Decree-Laws "Ristori", "Ristori Bis", "Ristori Ter", "Ristori Quater")[7];

- For all those households that had not received the other benefits and were not receiving the Citizenship Income: the Emergency Income was simulated for a maximum of 5 months, by integrating the dataset with open-data by the monitoring of the measure carried out by INPS[8].

Descriptive Indicators

Our analysis is developed on **households' equivalent disposable income**[9] that, accounting for net benefits received and intra-household redistribution effects, enables us to observe to what extent the extraordinary economic interventions adopted by the Government during 2020 have been able to cushion the marked drop of labor income. In particular,

(i) to estimate what would have been the **potential income loss** without the Government's interventions and the **actual loss** households experienced in 2020, we compare disposable income in the COVID-free scenario and the two alternative scenarios, namely:

$$\underline{\textit{POTENTIAL INCOME LOSS}}\ (\%) = (Y_{COVID\text{-}NO\text{-}INT} - Y_{COVID\text{-}FREE}) / Y_{COVID\text{-}FREE}$$

$$\underline{\textit{ACTUAL INCOME LOSS}}\ (\%) = (Y_{COVID\text{-}WITH\text{-}INT} - Y_{COVID\text{-}FREE}) / Y_{COVID\text{-}FREE}$$

(ii) to estimate **to what extent Government's interventions managed to compensate households' income losses**, we compare disposable income in the COVID-with-interventions scenario and the COVID-no-interventions scenario, namely:

$$\underline{\textit{\% LOSS COMPENSATED}} = (Y_{COVID\text{-}WITH\text{-}INT} - Y_{COVID\text{-}NO\text{-}INT}) / (Y_{COVID\text{-}FREE} - Y_{COVID\text{-}NO\text{-}INT})$$

[7] For self-employed workers and entrepreneurs, among the Government's interventions during 2020, we do not consider other minor measures for the coverage of firms' energy bills for lack of data, as well as the suspension of VAT and the regional tax on production (IRAP), as the microsimulation model concerns PIT only.

[8] A take-up rate is applied based on the monitoring open-data by INPS. In particular, 46 per cent of potential beneficiaries received 5 months, of the remaining part 76 per cent received 3 months

[9] Equivalent disposable income is the total net income a household has at its disposal for spending or saving, after having paid taxes and social security contributions and having received benefits, divided by the number of household members converted into equalised adults. Household members are equalised or made equivalent by weighting each according to their age, using the so-called modified OECD equivalence scale.

(iii) To illustrate the **income inequality and poverty dynamic**, we rely on the interquintile ratio (S80/S20)[10], the Gini index and the risk of poverty[11] indicator. We disentangle the **impact on inequality or poverty of both the pandemic economic consequences and the mitigation effect of interventions**, (comparing inequality indicators in the COVID-with-interventions and the COVID-free scenarios) and **the impact of the sole interventions**, overall and by type of measure (comparing inequality indicators in the COVID-with- and no-interventions scenarios), namely:

$\underline{\text{TOTAL IMPACT}}\ (\%) = (INEQ_{COVID\text{-}WITH\text{-}INT} - INEQ_{COVID\text{-}FREE}) \ / \ INEQ_{COVID\text{-}FREE}$

$\underline{\text{INTERVENTIONS' IMPACT}}\ (\%) = (INEQ_{COVID\text{-}WITH\text{-}INT} - INEQ_{COVID\text{-}NO\text{-}INT}) / (INEQ_{COVID\text{-}NO\text{-}INT})$

Regression estimates

To validate probability of losing income w.r.t. COVID-free scenario by some socio-demographic characteristics and assess the size of absolute compensation, we estimate two classes of models:

A logistic function:

$$Prob\_loss_i = \alpha + \beta_1 education\ level_i + \beta_2\ age_i + \beta_3\ family\_type_{i+}\ \beta_4\ area_i + \beta_5\ risk\_poverty_i + \varepsilon_i$$

A simple OLS:

$$Compensation_i = \alpha + \beta_1 education\ level_i + \beta_2\ age_i + \beta_3\ family\_type_{i+}\ \beta_4\ area_i + \beta_5\ risk\_poverty_i + \varepsilon_i$$

Where the dependent variable of the logistic is the probability of losing income, both in the COVID-with-interventions (first specification) and COVID-no-interventions (second specification) scenarios.

The dependent variable of the OLS is the difference between the disposable income in the with-interventions scenario and the disposable income in the counterfactual scenario; in other words, it represents the extra-income achieved due to the interventions.

The covariates represent the socio-demographic characteristics used in the analysis.

[10] Interquintile ratio index is defined as the ratio between the equivalized disposable household's income of the richest 20 percent and the poorest 20 percent of the population.

[11] The risk of poverty rate indicates the percentage of individuals whose income is lower than 60 percent of the median equivalized household's income.

4 Results

To illustrate how the pandemic and the Government economic interventions affected households' socio-economic conditions during 2020, we start from observing how the year 2020 would have been in a COVID-free scenario. Indeed, the microsimulation model enables us to estimate the effect of fiscal policies on households' income, simulating the disposable income households would have had in 2020 if the pandemic had not occurred[12]. **In these COVID-free circumstances, Italian households would have improved their socio-economic situation**, increasing their disposable income by 0,7% with respect to 2019 and experiencing a decrease in income inequalities due, in particular, to the fully implementation of Citizenship Income and, to a lower extent, to the introduction of the measures for the tax-wedge cutting.

To detect the actual socio-economic situation of households after one year of crisis and interventions, we focus on changes in **households' equivalent disposable income**: this experienced an **overall decrease of 1.7% in the COVID-with-interventions scenario** when compared with a COVID-free scenario, but it is 3.2 % higher than in a no-interventions scenario, showing that **Government's interventions consistently cushioned the potential loss** households would have experienced if interventions did not occurred. Even though the analysis is focused on disposable income, it is worth noting that the economic consequences of the shutdown produce a **labor income overall drop by more than 6%** with respect to a COVID-free 2020. In particular, self-employed and entrepreneurs, without instruments like the wage-supplementations scheme for employees, have borne the highest costs reporting a loss by more than 20% of the labor income they would have earned in 2020 without the pandemic.

The main interventions contributing to this result are:

- the wage-supplementation scheme for employees ("CIG") estimated in 18.2 billion euros gross, which involved 6.6 million employees who benefit from an average contribution close to 800 euros monthly for a total period, on average, of three and half months during 2020;

[12] In the COVID-free scenario we assume no variation in gross labor income with respect to 2019, while net disposable income varies according to the changes in fiscal policies occurred during 2020.

- the 600 euros lump-sum for all self-employed workers and entrepreneurs and the 1.000 euros lump-sum for professionals estimated in 5.8 billion euros; the non-refundable grant aid addressed to most affected self-employed workers and entrepreneurs amounting to almost 3 billion euros[13], with an average benefit of 1,701 euros per capita. Overall, almost 2.5 million self-employed workers and entrepreneurs received at least one of the non-refundable grants;
- the tax credit for rents for non-residential purposes for self-employed workers and entrepreneurs amounting to more than 727 million euros covering 620,000 recipients.
- the Emergency Income received by around 650,000 households not benefitting from any other types of benefits, accounting for a total amount of 1.5 billion euros.

Analyzing disposal income distribution and using the abovementioned inequality and poverty indicators, we provide some insights on the potential consequences that the crisis would have caused in absence of income-support policies, and on the real consequences that the pandemic has actually induced on the income level and its distribution. This information is crucial for policy planners, not only to assess at aggregate national level the overall mitigation effects of the policy response to the COVID-19 crisis, but especially to identify those who were more vulnerable to the shock and have been effectively supported by the interventions, and those instead who are still in a state of need.

To this latter purpose, the analysis provides some insights over the evolution of the economic effects of the first pandemic year and the disaggregation of the income losses, over the different scenarios, by some individual characteristics: income scale by quintile, geographic area, age, type of families' configuration and education level. Income inequality is also analyzed differentiating the contribution of various Government's interventions in its mitigation.

Results do not appear to ensure that inequalities and poverty risk will return to pre-COVID levels, inducing a concerning polarization of incomes and exhibiting heterogeneous effects in terms of both income losses and measures' compensation.

Distributive impacts

[13] It is worth to underline that these figures are referred only to individuals and partnerships and not to legal persons.

The **analysis by quintiles** of equivalent disposable income enables us to observe how households from different income classes have been affected by the pandemic crisis and how the Government faced it.

Government's interventions confirm to be effective, not only on the whole population, but also **to target the poorest individuals** that benefitted from a stronger compensation of their income losses (64%) with respect to the richest 20 per cent of individuals (41%) (Figure 2). This is mainly due to measures contrasting poverty like the Emergency Income, but it is also related to the fact that measures like the "CIG" for employees or lump-sum transfers like the 600 and 1.000 euros benefits were more effective in compensating lower incomes.

However, while interventions managed to almost completely offset disposable income losses of the second quintile of income distribution[14], **the 20 per cent poorest share of individuals still experience the harshest losses** relative to their disposable income in a COVID-free scenario (6.4 %). In some cases, these losses have been so severe that almost 618.000 individuals (5% of individuals in the first quintile) step back from the second to the first quintile of the income distribution with respect to their pre-COVID conditions (2019). At the same time, we observe that the richest 20 per cent of the population lost only around 1.2 per cent of their COVID-free disposable income, while being the one benefiting less from Government measures.

In brief, Government extraordinary **policies** to face the economic consequences of the pandemic have been effective to **protect the poorest incomes from a deep fall**, but this was **not enough to avoid the increase of the gap between the poorest and the richest part of the population**.

This polarization across the income distribution is captured by the dynamic of the **disposable income inequalities and risk of poverty rate.**

The **interquintile ratio**, indeed, is a measure of income inequality capturing the dynamic of the richest part of the population against the poorest one. Inequality was on a positive trend since 2017 that would have continued without the pandemic, leading to an interquintile ratio reduction by 0.1 point, setting to the level of 5.8 (Figure 3), thanks to the fiscal and income supporting policies previously mentioned (Citizenship Income and tax-wedge reduction measures).

[14] The households with an equivalent disposable income between around 10.500 and 15.100 euros in a year.

Due to the pandemic, **the inequality index is actually increasing by 5.2 per cent** (+ 0.3 points) in the with-interventions scenario, **falling back to the 2017 level** (6.1)[15], thus sterilizing the impact of the Citizenship Income firstly introduced in 2019 and fully operational from 2020. However, it would have increased by almost 14 per cent (+ 0.9 points) in the no-interventions scenario, so that the richest part of the population would have held almost 7 times the income at disposal of the poorest one (Figure 3). A similar dynamic is captured by the **poverty risk ratio** (Figure 4). Despite the fact that the share of individuals in relative poverty would have been reduced in 2020 if the pandemic had not occurred, Government's interventions strongly limited the severe increase of individuals at poverty risk that we would have experienced without Government's interventions (+1 p.p.), saving 440.000 people, mainly from the first quintile, from poverty risk.

This corroborates the fact that Government's interventions **have been successful in reducing the distance between the extreme parts of the income distribution** (interventions effect: -9 % in income inequalities and -3.3 in poverty risk, Table 1), **while not sterilizing completely the income polarization dynamic**.

Indeed, such polarization process is confirmed by the **Gini index** (Table 1 and 2), indicating a small decreasing in income inequality, - 0.9% with respect to a COVID-free scenario, and suggesting **the interventions were able to keep inequality under control over the whole population, while widening the distance between the poorest,** losing their income, **and the richest.** These latter, not only experienced a limited loss in their income in aggregate, but were also able to maintain or even increase their income more often than poorer households, as shown by the VAT return and electronic invoice data.

This concerning dynamic is likely to last even in the future considering that those who increased their income or maintained them, in an uncertain situation, preferred to increase savings and thus wealth in the medium term.

Loss distributions across income classes and results over income inequality and relative poverty are united in showing that, despite the effectiveness of measures, the ones who were already

[15] This figure converges to the preliminary Istat estimation of 2020 of the interquintile index, estimated under a macroeocnomic approach. The convergence of the micro and macro estimations is obtained by fixing caps to the self-employed and entrepreneurs income variations of each month of 2020 w.r.t. January 2020 (pre-pandemic reference month). In particular, income positive variations are limited to +100% w.r.t. pre-pandemic incomes, while income negative variations are limited to range between -600% for the self-employed and -1000% for entrepreneurs, according to outliers' distribution. These caps apply to a limited number of individuals, namely around 4% of all the self-employed and entrepreneurs in the sample.

belonging to the most disadvantaged part of the population are paying the highest cost of this crisis. In fact, by restricting the analysis to the 10 per cent of population facing the highest income loss compared to their 2020 COVID-free income, we noticed that **individuals most affected by the economic shock were the those already suffering, on average, by a lower disposable income and a greater risk of poverty** (Table 3), being, on average, younger workers and being mostly concentrated in sectors characterized by contractually less stable jobs and by a greater pervasion of "black economy" – mainly the retail trade, restaurant, agriculture, and construction sectors, among the ones mostly affected by the shutdown. Nearly 52% of individuals facing the highest income losses belong to the first quintile of the income distribution.

Impact by type of measures

Public policies adopted soon after the beginning of the pandemic have mitigated the inequality increase produced by the COVID-19 **to different extents** (Table 4).

On the one hand, the interventions addressed to self-employed and entrepreneurs consisted in mass and indiscriminate aids in the form of lump-sum transfers that, by their nature, absorbed a considerable amount of money while producing a limited effect in reducing inequality: resources between 1,200 and 2,200 euros per capita reflects in a 5.2% decrease in inequality. On the other hand, the Emergency Income resulted to be particularly effective in reducing inequality as it expanded the audience of the main measure against poverty in Italy (Citizenship Income): indeed, limited intervention of about 800 euros per capita reduced inequality by 25.8 %, showing the importance of targeted interventions in a generalized crisis with heterogeneous effects.

Lastly, the effects of the **Italian wage-supplementation scheme** ("CIG"), which is currently under reform, show the **limits and strengths of this instrument in protecting employees' incomes during a shutdown**. On the one hand, the "CIG" was created to address short period idiosyncratic firm crises as compared to longer period and systemic shocks like the one we are experiencing. As a result, with an average amount of less than 800 euros, it **only partially compensates monthly employees' income**, as it includes caps over certain income brackets and it is calculated on a without-fringe-benefits income that can be considerably lower than the "real income" employees normally rely on, also considering the prevalence of "black economy" in the job market, especially

in some of the sectors most involved by the shutdown. On the other hand, it is just its progressive features given by the caps and lower social-safety contributions to which is subject that make the "CIG" **more effective in compensating lower incomes**, resulting in reducing inequalities by almost 8.5% (Table 4).

Heterogeneous impacts

Furthermore, income distributions show that the **COVID-19 pandemic as a systemic shock involving the whole economy has resulted in idiosyncratic consequences for the population,** producing different effects across groups of individuals and, thus, stressing other types of inequality dynamics that were already strong in the pre-COVID period. To capture such differences across households, we analyzed income losses in the different scenarios by personal characteristics of the head of family (Figure 5 and 6).

Intergenerational effects show that elder people, despite experiencing the highest health costs, were the least affected by income losses being able to maintain their income, mostly related to pensions, financial and real-estate assets. On the contrary, younger individuals, especially people in working age, experienced the deepest disposable income loss (almost 3 per cent w.r.t. their 2020 COVID-free income), as well as the lowest rates of compensation by Government's interventions (around 60 per cent).

Looking at differences in **education level,** we observe that in Italy losses are concentrated among those having secondary and especially tertiary education, more often youths or individuals in the midst of their career, while those with post-tertiary titles, who could arguably have more stable and skilled jobs, mainly managed to maintain their incomes stable. As we are comparing income by personal characteristics of the head of the family, the income loss of the lower educated individuals is less pronounced since low skilled workers' losses are partially offset by elderly people, mainly in retirement and thus maintaining their income.

At family level, large families (3 or more children), in addition to struggling with schools' closures, are among the ones losing a higher part of their disposable income (around 2 per cent w.r.t. their 2020 COVID-free income) together with the couples, even though Government's interventions have been rather effective in compensating especially large families (66% of their losses). In

addition, sole parents with children, who are normally the ones facing higher difficulties being single-income households, seem to be those compensated the most, almost 70% of their losses.

At territorial level, the crisis seems to have led to a greater conversion between the North and the South of the country, due to the dramatic losses in Northern Italy, exposed for a longer time to the shutdown during the second pandemic wave as shown in Figure 6. In particular, households living in the North-West recorded the highest disposable income losses (2.1 per cent of their 2020 COVID-free income), while households in the South lost the lowest proportion of the income, they would have had in a COVID-free scenario (less than 1 per cent). Although Government's interventions mitigated the potential losses of the whole national territory, the highest degree of compensation is observed in the South and on the Islands (77% of their 2020 COVID-free income), arguably reflecting the higher concentration of interventions on the individuals with lower incomes.

Model estimates confirm such figures. Table 5 presents the probability of losing income, both in a COVID-with-interventions (column 1) and COVID-no-interventions scenario (column 2), as function of the basic socio-economic characteristics examined so far.

In addition, the size of the compensation is presented with simple OLS (column 3), where the dependent variable is the extra income achieved due to the interventions. According to the results, despite the interventions, educated individuals with secondary and tertiary education report a probability of losing their income w.r.t. COVID-free scenario between 1.2 and 1.4 times higher than individuals with no education, and the result would have been even stronger in a no-interventions scenario. Similarly, individuals in working age report a probability of losing their income 1.6 (age 46-55) to 2.1 (age 25-35) higher than individuals aged 65 or above.

In terms of family type, households, especially if numerous, confirm to be the group strongly affected by the crisis, with singles and couples reporting a significant lower probability of losing their income (between 0.2 and 0.4) than families with more than 3 children.

Government's interventions confirm to have successfully targeted the poorest part of the population. Indeed, if looking at individuals at risk of poverty, their probability of losing income in the with-interventions scenario is not statistically different from that of the individuals non-at risk of poverty (1.0), while, without a policy response, the poorest would have been 1.4 times more likely to lose their income than those not poor.

Such compensative effect is particularly evident in the analysis by type of worker. Despite the interventions, as expected both employees and the self-employed report a higher probability of loss (3.3 and 3.7 respectively) compared to non-workers. However, the coefficients of the two groups of workers are not statistically different from each other, suggesting that employees and self-employed workers had the same probability of loss after the interventions. The latter is no longer true when moving to the counterfactual scenario without interventions, where the self-employed register a probability of loss 16 times higher than non-workers, while employees display a probability of loss reduced to 4.0. This time, the coefficients of the two groups (self-employed and employee) are statically different, meaning that the self-employed, without government's interventions, would have experienced an income loss considerably higher (on average 1.288 euros) than employees (311 euros).

In conclusion, these results show that **different population groups were affected by an asymmetric economic shock**. Poorest individuals, in the midst of their working career, especially if self-employed and with children, were the most challenged by the deep income losses that the pandemic has caused. However, consequences would have been dramatic for these groups if the Government had not intervened, being effective in compensating the most vulnerable groups.

5 Concluding remarks

Combining a traditional microsimulation model on individual level data from administrative and survey source with more frequently available firm level data, the work is an innovative example of how it is possible to nowcast current individual changes in disposable income in a context of uncertainty and heterogenous effects like the COVID-19 pandemic to provide real-time information on poverty and inequality dynamics in order to tailor policy responses to support the most vulnerable individuals.

The analysis, in line with most of the related studies for Italy (Gallo and Raitano (2020); Brunori et al. (2020)) suggests that the Great-lockdown is leading to an acceleration in income polarization with an increase in the gap between the richest and the poorest part of the population. The latter is still experiencing the harshest losses, even though this time, massive and timely interventions by the

Government, substantially cushioned the severe economic consequences of the crisis. Indeed, individuals experiencing the highest losses were already suffering from a stronger socio-economic vulnerability before the pandemic outbreak, in terms of lower disposable income, greater risk of poverty, less stable jobs and younger careers, contributing to the polarization in income losses.

Overall, Government's interventions have been effective in mitigating the severe impact of the crisis by limiting the overall increase in income inequalities and relative poverty and, especially, by targeting the most vulnerable individuals, which benefitted from a consistent compensation of their income losses. This was overall stronger than the compensation received by the richest part of the population, even if effects are heterogeneous across personal and household characteristics.

In particular, besides inducing an income polarization, the COVID-19 pandemic risks to exacerbate other inequality dynamics, resulting in an asymmetric shock between generations – affecting mostly youths and those in the midst of their working careers (age 25-45) – as well as challenging mostly self-employed workers and families with children (with the exception of sole parent households).

Moreover, the evaluation of inequality by type of measure shows that selective and progressive interventions such as the Emergency Income are particularly effective in reducing inequality, while mass and indiscriminate aids, such as the ones allocated in the first phase of the pandemic, absorb a considerable amount of money without resulting in a consistent decrease in inequality.

In this work, we focus on the effects of the sole discretionary policies that the Government implemented during 2020 to face the pandemic, without looking at the effects that automatic stabilizers and the progressive features of our fiscal system would have produced if other extraordinary measures did not occur.

It is important to underline that the data and model used do not allow to take into account the labor market dynamics occurring during 2020 (even if mitigated by the blocking of layoffs) and to disentangle some of the within-groups inequalities, namely disparities within economic sectors, or within firms, which could further help designing future interventions. Indeed, when the blocking of layoffs and the wage-supplementation scheme will be gradually removed, inequalities among low-skilled and more disadvantaged workers and those doing high-skilled jobs, more likely to have been

in smart-working with higher possibilities to maintain their job even later, will arguably increase if proper measures will not be taken.

Moreover, the work just focuses on households' income inequality, being unable to directly capture other forms of inequalities the pandemic has certainly deepened, such as: gender inequalities, health inequalities, and inequalities experienced by young people under the age of 25 in remote-teaching, which due to digital divide and different household's socio-economic conditions, will arguably have long-term consequences in terms of human and social capital development.

However, if considering income as one of the most important drivers interacting with other forms of inequality, future interventions need to keep on supporting the incomes of these most vulnerable groups that, besides experiencing the highest losses, could face the harshest consequences in the job market in the future, as to avoid an exacerbation of poverty and a future and further intensification of inequalities.

Statements and Declarations

Competing interests

Authors declare they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The views and opinions expressed in this manuscript are those of the authors and do not necessarily reflect the official policy or position of their institutions.

Informed Consent

Ethical Approval not provided: the research does not involve human participants or animals,

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Data Availability Statements

The datasets generated and/or analyzed during the current study belong to the database of the Italian Department of Finance. Therefore, they are not publicly available for confidentiality reasons. They are available from the corresponding author on reasonable request.

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Tables

Box 1. Methodological framework for the imputation of the income's change and COVID-related benefits.

Type of worker	Data used	Imputation of the income change	Imputation of the government COVID-19 interventions
Employees	administrative firm-level data by the Italian National Social Security Institute (INPS) on the personnel cost paid by each firm in each month of 2020	We derive personnel cost variation, within the stratum NACE 6-digit - Italian region, computing monthly indicators of the percentage variation of the salaries paid by firms for each "COVID month" (March - December 2020) with respect to those paid in the "pre-COVID month" (January 2020). We then assign individuals to CIG by casually drawing in each sector/region the number of employees whose cumulated share of the total gross salary (included employer's s.s.c.) in the sector and region is equal to the reduction of firms' personnel cost in that sector and region. We repeat this operation for each month between March and December 2020[16]. In the COVID-with-interventions scenario: 2020 yearly gross of tax income = $\frac{2}{12} * PreCOVID_{yearlyincome} + \frac{10-x}{12} * PreCOVID\_yearlyincome + \sum_1^x CIG_m$. Where *m* is the month in which the employee is assigned to CIG and ranges from 1 to x with a maximum value of 10 (number of months from March to December). $PreCOVID\_yearlyincome$ is the employees' original income (net of ordinary s.s. contributions) and CIG is the monthly CIG (net of CIG's s.s. contributions that are at a lower rate w.r.t to the normal employees' income). In the COVID-no -interventions scenario: not having other types of data on the job market, we assume that individuals assigned to CIG experience a full loss of income considering that, without the CIG and the blocking of layoffs introduced by the Government during the same period, they would have had higher probability to lose their job. Individuals not assigned to CIG do not experience any income losses.	• wage-supplementation scheme (CIG): 80 per cent of gross income with a maximum of 939.89 euros if income is up to 2159.48 euros; if income exceeds the latter, the maximum is increased to 1129.66 euros. • blocking of layoffs for the entire period
Self-employed and entrepreneurs	periodic VAT returns of 2020 at firm level (turnover and costs of goods and services data) electronic invoicing of 2020 at NACE 6-digit level (turnover data)	For each "COVID month" (March - December 2020) with respect to January 2020, based on VAT returns, we derive monthly indicators expressing the percentage variation in the costs of goods and services and turnover of firms at NACE 6-digit level – Italian region. These indicators are applied to the income positive and negative components from 2018 PIT returns to derive the income variation at individual level. When the VAT data were not available, electronic invoice data were used, applying to turnover variation an elasticity equal to the median elasticity of the firms for which the VAT data were available. The turnover variation is estimated applying a correction to the electronic invoice values by means of the periodic VAT returns data that are more complete, as the electronic invoice does not include the turnover from B2C transactions.	• 600 euros lump-sum • 1.000 euros lump-sum benefit for self-employed professionals • non-refundable grant aid and tax credit for rents for non-residential purposes assigned based on the income variation w.r.t. 2019 derived by the electronic invoicing of 2020 at NACE 6-digit level

[16] Example: if in the sector 15.12.09 in Lazio region the personnel cost in March 2020 decreased by 30% w.r.t to January 2020, once casually ordered employees of the sector 15.12.09 in Lazio region by their share of the total gross salary of the sector 15.12.09 in Lazio, we select those employees whose cumulated share of the total gross salary in the sector 15.12.09 in Lazio region amounts to 30%.

Table 1. Impact of COVID-19 pandemic and 2020 Government's interventions on disposable income inequalities.

	Total impact	**Interventions' impact**
Impact - interquintile ratio	+5.2 %	-9.0%
Impact - Gini index	-0.9 %	-3.0%
Impact - poverty risk	+2.0%	-3.3%

Source: Authors' estimates under the TAXBEN-DF micro-simulation model.

Table 2. Gini index, years 2019-2020.

Gini index 2019	**Gini index COVID-free scenario**	**Gini index COVID-no-interventions**	**Gini index COVID-with-interventions**
0.325	0.323	0.330	0.320
[.322 -.329]	[.319 - .327]	[.326 - .333]	[.316 - .324]

Source: Authors' estimates under the TAXBEN-DF micro-simulation model.
95 % Confidence Interval in parenthesis.

Table 3. Some socio-economic, familiar and personal characteristics of the 10% of individuals with the highest disposable income losses.

Socio-economic characteristics			
	Total population	*10% of individuals with the highest losses*	*p-value of the difference*
Average equivalent disposable income in 2019	22,188	11,982	0.000
Poverty rate in 2019	12%	51%	0.000
Not able to afford an unexpected expense of 800 euros (*)	30%	50%	0.000
Familiar and personal characteristics			
	Total population	*10% of individuals with the highest losses*	
Average age (*)	48.2	37.8	0.000
Average n. of family's components (*)	2.79	3.05	0.000
Main NACE sectors of occupation (*)	1) retail trade; 2) education; 3) agriculture; 4) sanitary services and public administration	1) retail trade; 2) restaurants; 3) agriculture; 4) construction	

Source: ITS-SILC 2018 and Authors' estimates under the TAXBEN-DF micro-simulation model.
(*) Refers to reference year of the IT-SILC survey, i.e. 2018.

Table 4. Impact of the main Government measures adopted in 2020 on income inequality (Gini index).

	Gini index COVID-no-interventions	**Gini index COVID-with-interventions**	**Impact**
Wage-supplementation scheme ("CIG"; employee)	0.305	0.279	**-8.5%**
	[.296 - .313]	[.271 - .287]	
Lump-sum transfers, grants and tax credit for fixed costs (self-employed and entrepreneurs)	0.362	0.343	**-5.2%**
	[.348 - .375]	[.330 - .357]	
Emergency Income	0.457	0.339	**-25.8%**
	[.413 - .500]	[.313 - .365]	

Source: Authors' estimates under the TAXBEN-DF micro-simulation model. *Income inequalities are measured using the Gini index. Impact of Government's interventions is measured as percentage variation of Gini index between the with- and no-interventions scenarios. 95 % Confidence Interval in parenthesis*

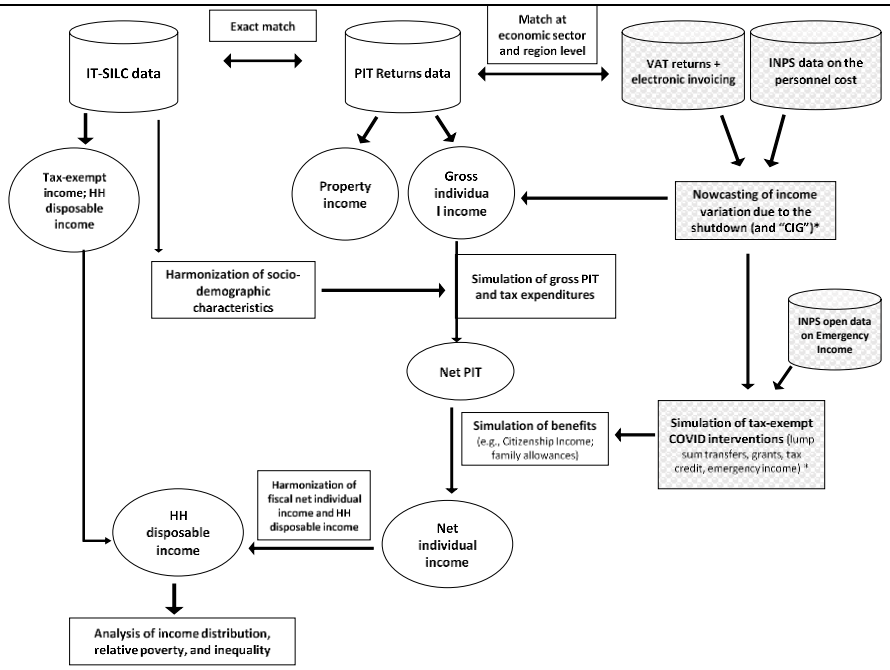
Table 5. Probability of losing income w.r.t. the COVID-free scenario and absolute compensation.

	COVID-with-interventions	COVID-no-interventions	Loss compensation
VARIABLES	(1) prob_loss W.I.	(2) prob_loss N.I.	(3) compensation
level of edu: ref no education			
primary	1.483**	1.568**	84.27***
	(0.292)	(0.287)	(22.36)
secondary	1.461*	1.573**	101.5***
	(0.293)	(0.294)	(27.15)
Tertiary/post tertiary	1.297	1.396*	71.00*
	(0.268)	(0.271)	(37.96)
age: ref >65			
0-24	1.271	1.229	358.4**
	(0.423)	(0.339)	(162.3)
25-35	2.170***	1.649***	267.3***
	(0.240)	(0.177)	(43.66)
36-45	1.588***	1.160	182.7***
	(0.154)	(0.110)	(33.32)
46-55	1.654***	1.271***	226.4***
	(0.157)	(0.118)	(34.17)
56-65	1.981***	1.545***	224.2***
	(0.169)	(0.129)	(29.17)
family type: ref family with >3 child			
sole parent	0.773*	0.881	212.4***
	(0.109)	(0.128)	(62.05)
single	0.252***	0.246***	44.42
	(0.033)	(0.033)	(58.16)
couple	0.439***	0.433***	88.94
	(0.060)	(0.061)	(59.56)
parents up to 2 children	0.838	0.912	95.10*
	(0.107)	(0.122)	(57.75)
area: ref south and islands			
north-west	1.169**	1.236***	-13.56
	(0.081)	(0.087)	(26.82)
north-east	1.252***	1.285***	-41.12
	(0.085)	(0.089)	(25.08)
center	1.237***	1.326***	41.75
	(0.087)	(0.095)	(26.85)
occupational status: ref non-workers			
employee	3.340***	4.076***	311.8***
	(0.230)	(0.294)	(26.65)
self-employed and entrepreneurs	3.700***	16.822***	1,288***
	(0.300)	(1.525)	(44.19)
risk of poverty	1.004	1.423***	54.53**

	(0.069)	(0.094)	(22.80)
Constant	0.106***	0.109***	-36.53
	(0.025)	(0.024)	(60.14)
Observations	20,331	20,331	20,331
R-squared	0.157	0.233	0.157
employee=self-employed/entrepreneurs	1.988	296.8***	391.5***

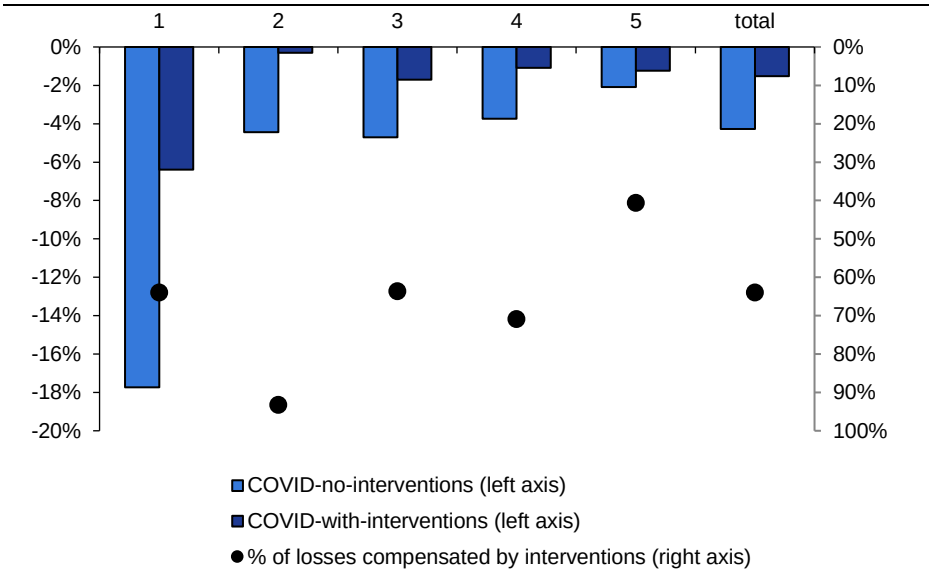
Figures

Figure 1. The TAXBEN-DF model and the estimation process of income distribution effects of COVID-19.



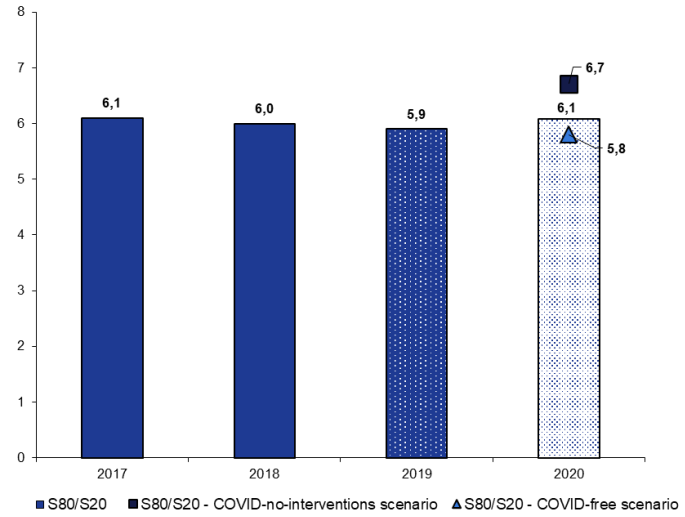
Source: Authors' elaboration. *(*) Included in the COVID-with-interventions scenario only.*

Figure 2. Percentage variation of disposable income by quintiles of equivalent disposable income.



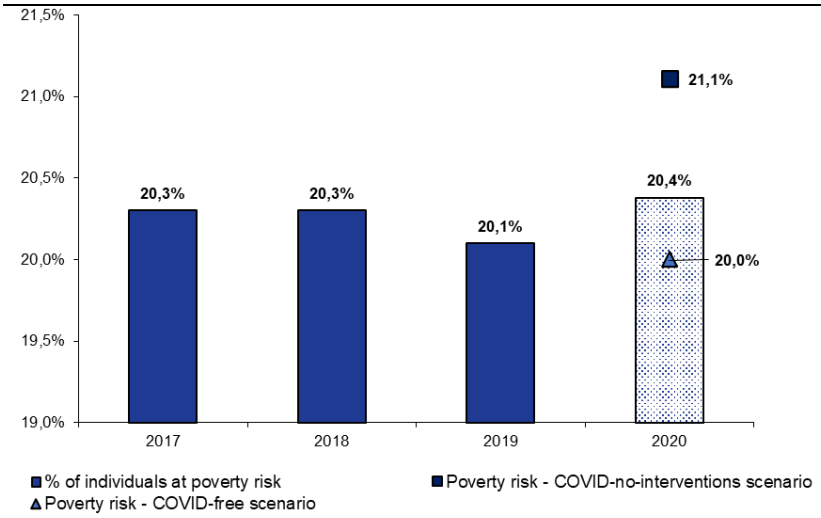
Source: Authors' estimates under the TAXBEN-DF micro-simulation model. *In each scenario, the percentage variation is calculated w.r.t. the COVID-free scenario.*

Figure 3. Interquintale ratio –years 2017-2020



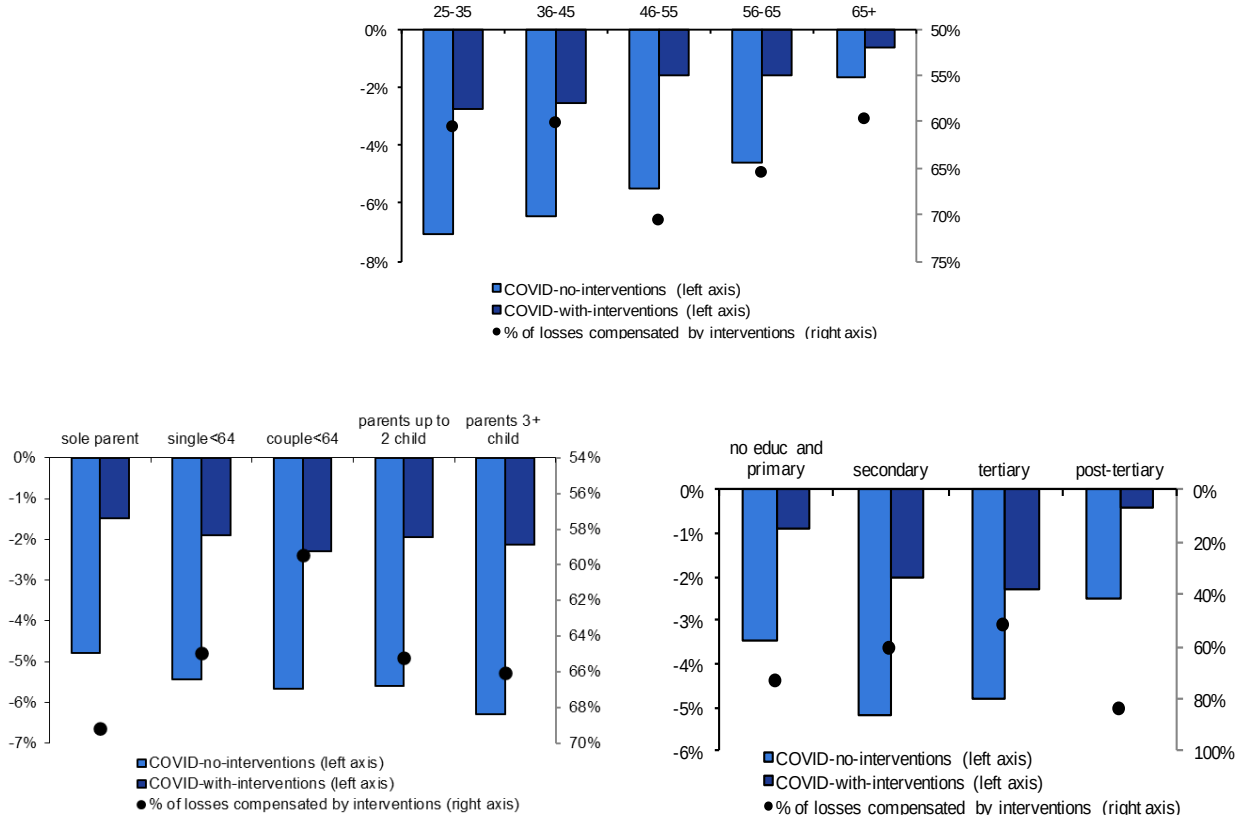
Source: 2017-2019 Istat, EU-SILC Survey; 2019 Istat estimates under a macroeconomic approach; 2020: Authors' estimates under the TAXBEN-DF micro-simulation model. *For 2020, the column shows the data of the with-interventions scenario in which the economic effects of both the pandemic and the Government measures are considered.*

Figure 4. Percentage of individuals at poverty risk –years 2017-2020



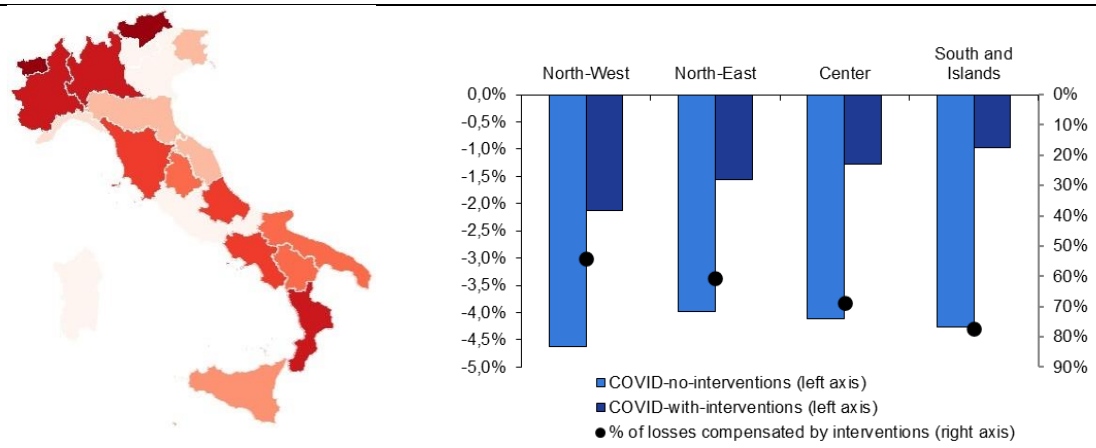
Source: 2017-2019 Istat, EU-SILC Survey; 2020: Authors' estimates under the TAXBEN-DF micro-simulation model.
For 2020, the column shows the data of the with-interventions scenario in which the economic effects of both the pandemic and the Government measures are considered.

Figure 5. Percentage variation of disposable income by age (above), family composition (below left), and education (below right)



Source: Authors' estimates under the TAXBEN-DF micro-simulation model. *In each scenario, the percentage variation is calculated w.r.t. the COVID-free scenario. For this analysis, we compare the equivalent disposable income by personal characteristics of the head of the household, as classified in EU-SILC.*

Figure 6. Map of the number of days with restrictive measures during the second pandemic wave (DPCM, 3 November 2020) (left); Percentage variation of disposable income w.r.t. the COVID-free scenario by main geographic areas (right)



Source: Map, MEF (2020b). Graph, Authors' estimates under the TAXBEN-DF micro-simulation model. *In each scenario, the percentage variation is calculated w.r.t. the COVID-free scenario. For this analysis, we compare the equivalent disposable income by personal characteristics of the head of the household, as classified in EU-SILC.*
The map assumes a different gradation of red based on the number of days in which each region has been in a certain colour band (yellow, orange, red) that indicates the level of pandemic risk in each region and the consequent harshness of the shutdown during the second pandemic wave (from dark red for the regions that have been in red band for the highest number of days, to clear rose for regions that have always been in yellow band).